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The Impact of Motor Abilities on Belly Dance Performance in Female High School Students

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A B S T R A C T

The aim of the study was to determine the relation of motor abilities and belly dance performance in female high school students, 1st to 4th graders aged 15–18 years. A battery of 19 motor tests were used and nine belly dance elements evaluated in the study sample that included 148 students aged 15–16 (1st and 2nd graders) and 123 students aged 17–18 (3rd and 4th graders). Factor analysis of the motor space isolated six factors in either study group: in 1st and 2nd graders, the first factor integrated coordination, trunk strength, aerobic and muscle endurance, and speed of lower extremity movements; second factor defined explosive strength; third factor defined flexibility; fourth factor defined rhythm coordination; fifth factor defined equilibrium; and sixth factor defined back musculature strength; in 3rd and 4th graders, the first factor integrated coordination and lower extremity explosive strength; second factor defined flexibility; third factor integrated trunk strength and aerobic-muscular endurance; fourth factor defined equilibrium; fifth factor defined rhythm coordination; and sixth factor defined lower extremity strength. Factor analysis of the scores allocated to particular belly dance elements isolated only one factor as a factor of the general specific ability for belly dance performance. Regression analysis in the latent space indicated the factor of flexibility, which is responsible for muscle tone regulation, to be the best predictor of belly dance performance in 1st and 2nd graders. In 3rd and 4th graders, the factor of rhythm coordination was found to be superior in predicting belly dance performance, followed by the factor of trunk strength and aerobic-muscular endurance, the factor integrating coordination and lower extremity strength, and factor of equilibrium.

Key words: *kinesiologic education, belly dance, motor status, female high school students*

Introduction

Dance is an irreplaceable teaching tool in kinesiologic education of female subjects, from elementary school through university education because, among other qualities, it contributes to the development and maintenance of the basic motor abilities[1–3]. In medicine, dance has a special role as a therapeutic instrument, where dance structures are used as kinesiologic operators in transformation and maintenance of the achieved levels of anthropological status functions[4–7].

Srhoj et al. (2006)[2] found latent structure of the *cicilionа* and *pašavijen* folk dances to be predominated by coordination, while the social dance rock'-n'-roll was predominated by explosive strength, and cha-cha-cha by explosive strength and speed. These authors conclude that overall dance performance in university students depends mostly on coordination, then on explosive strength, and to a lesser degree on speed (movement frequency). Following reports on the value of dance as a kinesiologic operator[1–3,8–11], Viskić-Štalec et al. (2006)[12] investigated utility of a program consisting exclusively of dance structures in the form that would maximally corespond with all the requirements posed by the physical education curriculum and syllabus. The varied program composed of folk dances and social dances, various types of aerobics and elements of rhythmical gymnastics, with due quality of performance, was found to exert complex and significant impact on the morphological-motor status of high school female students. The experimental program had greatest influence on agility/coordination. The dance-aerobics training also has considerable influence on aerobic endurance, meaning that the volume of work was sufficient to provoke changes and development of this basic motor ability[13]. This was followed by the significant effect of the experimental program on the ability of rhythm as a specific coordination integrating different routines and music into a harmonious and esthetic movement structure.

Belly dance has recently been increasingly chosen by women when deciding on recreational dance activities. In

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addition to young women, ever more middle aged women join dance programs of this type. The basic elements of belly dance are stretching, isolation of ribs, isolation of upper extremities, isolation of palms, hip circle, hip bounce, horizontal figure 8, vertical figure 8, Egyptian shimmy, and shoulder shimmy.

Belly dance is mostly practiced as a recreational activity in which the choice of elements and performance should not be strictly defined, so that attendants can at the same time improve or maintain a satisfactory level of their anthropological status and achieve emotional relief.

In 2007, Mihaljević et al.[3] conducted belly dance treatment in a sample of female elementary school 5th and 6th graders to investigate the relation between motor ability tests and belly dance performance scores at the beginning and at the end of treatment. A series of regression correlation analyses were used on initial and final measurement to determine relations between the latent motor variables and criterion variables. On initial measurement, factor responsible for muscle tone regulation and factor integrating the strength of legs, coordination of movement frequency of arms and legs, and agility were found to be the best predictors of belly dance performance. On final measurement, factor named rhythm coordination (accompanied by muscle tone regulation) and factor defined by repetitive strength of the trunk and legs were the best predictors of belly dance performance.

The aim of the present study was to assess the inter-relationship of motor abilities and belly dance performance in female high school students, i.e. in 1st–2nd graders (age 15–16) and 3rd–4th graders (age 17–18) in separate. Differences in motor functioning between the two age groups were analyzed according to the quality of particular belly dance element performance.

Subjects and Methods

Subject sample

Study subjects were selected from a population defined as clinically healthy female high school students attending 1st, 2nd, 3rd and 4th grades at Healthcare Education Center, aged 15–18 years, able to attend physical training classes. A total of 272 students were divided into two age groups: age 15–16 (n=148) and age 17–18 (n=123).

According to the experimental procedure protocol, kinesiologic treatment with belly dance structures was performed during physical training classes, two periods weekly *per* class for six weeks.

Variable sample

Motor variables were so chosen as to provide the best possible assessment of the basic motor abilities considered relevant for dance performance[14–17]. The following variables were employed on motor status evaluation: polygon backward (POLB) and sidesteps (SS) (coordination); hand tapping (HTAP) and foot tapping (FTAP) (movement frequency); non-rhythmic tapping (NRTAP) and hand and foot tapping (HFTAP) (rhythm coordination); forward bow (FB) and bench touch-toe (BTT) (flexibility); bench standing – eyes closed (BSEC) and bench standing – eyes open (BSEO) (equilibrium); standing jump (SJ), 20-m run (R20M) and medicine ball supine throw (MBST) (explosive strength); sit-ups (SU), prone sit-ups (PSU) and crouch (CR) (repetitive strength); bent arm hang (BAH) and lever hang (LH) (static strength); and 6-min run (R6MIN) (functional ability, i.e. aerobic endurance).

The following 9 variables were used on assessment of the belly dance motor skills (performance scores for three arm, trunk and hip elements each): isolation of upper extremities, isolation of trunk, breathing and chest movements, hip circle, hip bounce, horizontal figure 8, vertical figure 8, Egyptian shimmy and shoulder shimmy. Three independent evaluators (professors of kinesiology) ranked performance of 9 belly dance elements on a 1–5 scale by analysis of video records.

Statistical analysis

Analysis of variance was used to determine differences in motor abilities and 9 belly dance elements between the groups of students: 1st–2nd graders and 3rd–4th graders (F-test, p).

Factor analysis was used to determine factor structure in the sample of motor variables (with calculation of the following variables: V – significant varimax factors according to Guttman-Kaiser criterion of $\lambda > 1$; Lambda – characteristic values; and Variance % – percentage of variance explained by each latent dimension).

Regression correlation analysis was employed to determine correlation between the set of motor variables and criterion variable, with calculation of the regression coefficient (β), coefficient of multiple correlation of the set of predictors with the criterion (ρ), and level of significance of multiple correlation.

Results

Basic parameters of the predictor, i.e. motor variables, performance scores of belly dance elements as criterion variables, and results of the analysis of variance between the two age groups (1st–2nd *vs.* 3rd–4th graders) are presented in Table 1.

The analysis of variance of motor variables showed the older age group (3rd–4th graders) to have significantly better results than the younger age group (1st–2nd graders) on the tests of arm movement frequency, abdominal muscle repetitive strength, static trunk strength, and rhythm coordination with upper and lower extremity movements, while being less successful on the tests of explosive strength of throw type, repetitive strength of back musculature, and agility. Although 3rd–4th graders were generally superior to 1st–2nd graders in terms of motor abilities, the results indicated inadequate development of some motor abilities in the former, probably due to inadequate kinesiologic activity in high school senior grades. Analysis of variance yielded no significant be-

TABLE 1
DESCRIPTIVE STATISTICS AND ANALYSIS OF VARIANCE BETWEEN 1st–2nd AND 3rd–4th GRADE FEMALE HIGH SCHOOL STUDENTS IN BASIC MOTOR ABILITY TESTS AND BELLY DANCE ELEMENT SCORES

Variable	1st and 2nd graders (n=148)		3rd and 4th graders (n=123)		F-test	p
	Mean	SD	Mean	SD		
Polygon backward#	14.25	2.56	14.71	2.07	2.56	0.11
Sidesteps#	13.82	1.60	14.40	1.62	8.76	0.00
Hand tapping	34.33	3.12	36.38	3.25	27.95	0.00
Foot tapping	18.53	1.71	18.60	1.71	0.10	0.75
Non-rhythmic tapping	11.67	2.64	11.33	2.22	1.35	0.25
Hand and foot tapping	9.14	2.35	9.99	2.05	9.94	0.00
Forward bow	71.50	11.43	73.67	11.62	2.39	0.12
Bench touch-toe#	–7.06	6.80	–7.35	7.32	0.11	0.74
Bench standing-eyes closed	1.82	0.65	1.89	0.64	0.95	0.33
Bench standing-eyes open	3.16	1.72	3.32	1.55	0.68	0.41
Standing jump	167.42	20.02	167.97	18.90	0.05	0.82
20-m run#	3.94	0.35	3.98	0.30	1.41	0.24
Medicine ball throw	169.69	41.30	150.74	42.17	13.89	0.00
Sit-ups	36.13	8.53	40.00	7.76	15.05	0.00
Prone sit-ups	47.47	10.26	43.07	10.16	12.47	0.00
Crouching	25.29	3.18	26.09	2.85	4.62	0.03
Bent arm hang	29.83	17.65	33.97	18.37	3.57	0.06
Lever hang	49.19	19.54	57.40	19.73	11.77	0.00
6-min run	1060.13	113.30	1033.43	124.91	3.40	0.06
Isolation of arms	3.19	0.93	3.31	0.85	1.13	0.29
Isolation of chest	3.18	0.85	3.29	0.80	1.31	0.25
Breathing and chest movements	3.39	0.80	3.46	0.79	0.51	0.48
Hip circle	3.39	0.76	3.49	0.76	0.98	0.32
Hip bounce	3.40	0.88	3.49	0.80	0.70	0.40
Horizontal figure 8	3.41	0.87	3.49	0.76	0.67	0.41
Vertical figure 8	3.19	0.89	3.22	0.84	0.04	0.84
Egyptian shimmy	3.50	0.87	3.47	0.83	0.07	0.78
Shoulder shimmy	3.81	0.80	3.79	0.71	0.07	0.78

#variable with opposite metric orientation

tween-group differences according to scores for belly dance element performance.

In order to provide comprehensive information on the latent structure of belly dance in the space of motor abilities, results of the factor analysis of motor variables and factor analysis of the variables assessing specific motor skills in belly dance are presented first for junior and senior high school students (Tables 2 and 3), followed by relations between thus formed latent motor and specific motor variables, in separate for junior and senior high school students (Table 4).

In 1st–2nd graders, factor analysis isolated 6 factors in motor space (Table 2). The first factor showed equally high projections of the tests assessing coordination, trunk repetitive strength, aerobic endurance and static strength of upper extremities, i.e. muscle endurance. This factor integrated the information component of motion (coordination tests and test of lower extremity movement frequency) and energy component of motion (tests of trunk repetitive strength and tests of aerobic and muscle endurance) into general motor efficiency of this study group. The tests used on explosive strength assessment showed highest projections upon the second factor, thus it could be termed factor of explosive strength. Other factors were also clearly and distinctly defined as follows: third factor as flexibility factor, fourth factor as rhythm coordination factor, fifth factor as equilibrium factor, and sixth factor as back musculature strength factor.

In 3rd–4th graders, factor analysis also isolated 6 factors in motor space (Table 2). The first factor showed equally high projections of the tests assessing coordination and tests assessing explosive strength of the jump

TABLE 2
RESULTS OF FACTOR ANALYSIS OF VARIABLES ASSESSING MOTOR ABILITIES

Variable	1st and 2nd graders (n=148)						3rd and 4th graders (n=123)					
	V1	V2	V3	V4	V5	V6	V1	V2	V3	V4	V5	V6
POLB #	–0.54	–0.08	–0.29	–0.29	0.29	–0.01	–0.67	–0.20	–0.04	0.28	–0.09	0.27
SS#	–0.69	–0.01	–0.26	–0.09	0.19	–0.10	–0.59	–0.12	–0.12	0.18	–0.25	–0.00
HTAP	0.32	0.23	0.03	0.55	0.03	–0.02	0.40	–0.02	0.05	–0.11	0.35	0.46
FTAP	0.60	0.28	–0.04	0.07	0.03	0.31	0.37	0.23	0.17	0.08	0.39	0.24
ntblNRTAP	0.25	–0.19	0.12	0.72	–0.01	0.05	0.07	–0.07	0.05	–0.00	0.81	0.04
HFTAP	–0.19	0.07	0.04	0.76	0.05	0.08	–0.03	0.32	–0.01	0.02	0.70	–0.04
FB	0.23	0.01	0.82	0.10	0.03	0.02	0.16	0.86	0.02	–0.05	0.03	–0.04
BTT#	–0.05	–0.15	–0.83	–0.09	0.10	–0.16	–0.00	–0.85	–0.11	0.16	–0.10	–0.12
BSEC	0.12	0.04	0.04	–0.16	–0.82	0.10	0.06	0.02	0.03	–0.81	–0.07	–0.06
BSEO	0.12	0.16	0.03	0.08	–0.80	–0.02	0.32	0.08	0.15	–0.72	0.08	0.07
SJ	0.32	0.58	0.01	0.22	–0.03	0.03	0.57	0.30	0.27	–0.09	–0.00	0.07
R20M#	–0.04	–0.77	0.00	0.04	0.10	0.02	–0.64	0.14	–0.09	–0.05	0.24	–0.36
MBST	–0.02	0.66	0.34	–0.06	–0.03	–0.05	0.28	0.49	0.03	0.23	0.20	0.06
SU	0.62	0.02	0.34	–0.10	–0.22	–0.03	0.12	0.12	0.52	–0.19	0.32	0.31
PSU	0.51	0.05	0.19	–0.06	–0.07	0.51	0.07	0.33	0.60	–0.15	0.10	0.21
CR	0.35	0.49	–0.08	0.02	–0.17	0.18	0.00	0.11	0.17	0.03	0.00	0.76
BAH	0.53	0.07	0.14	0.17	–0.23	–0.37	0.16	–0.03	0.62	0.41	–0.06	–0.36
LH	0.09	0.01	0.12	0.14	–0.08	0.83	–001	–0.10	0.68	–0.37	0.01	0.18
R6MIN	0.66	0.28	–0.18	0.12	0.10	0.13	0.41	0.05	0.64	0.12	–0.05	0.03
Lambda	3.00	1.92	1.88	1.68	1.62	1.29	2.25	2.18	2.09	1.77	1.72	1.39
Variance%	0.16	0.10	0.10	0.09	0.09	0.07	0.12	0.11	0.11	0.09	0.09	0.07

#variable with opposite metric orientation
V – significant varimax factors, Lambda – characteristic values, Variance % – percentage of variance explained by a particular factor
POLB – polygon backward, SS – sidesteps, HTAP – hand tapping, FTAP – foot tapping, NRTAP – non-rhythmic tapping, HFTAP – hand and foot tapping, FB – forward bow, BTT – bench touch-toe, BSEC – bench standing-eyes closed, BSEO – bench standing-eyes open, SJ – standing jump, R20M – 20-m run, MBST – medicine ball supine throw, SU – sit-ups, PSU – prone sit-ups, CR – crouching, BAH – bent arm hang, LH – lever hang, R6MIN – 6-min run

TABLE 3
FACTOR ANALYSIS OF MOTOR SKILLS (IN BELLY DANCE) VARIABLES

Variabe	1st and 2nd graders (n=148)	3rd and 4th graders (n=123)
	V1	V1
Isolation of arms	–0.87	–0.84
Isolation of chest	–0.91	–0.90
Breathing and chest movements	–0.87	–0.91
Hip circle	–0.91	–0.92
Hip bounce	–0.92	–0.91
Horizontal figure 8	–0.93	–0.90
Vertical figure 8	–0.92	–0.89
Egyptian shimmy	–0.91	–0.90
Shoulder shimmy	–0.90	–0.88
Lambda	7.36	7.21
Variance%	0.82	0.80

V – significant varimax factors, Lambda – characteristic values, Variance % – percentage of variance explained by a particular factor

and sprint type. Thus, this factor integrated coordination and explosive strength of lower extremities into a general motor ability that predominantly underlay motor functioning of this study group. Second factor was defined by the tests assessing flexibility, based on muscle tone regulation. Third factor was defined by the tests assessing basic trunk strength and tests assessing muscle and aerobic endurance. Accordingly, this factor regulated the length of energy mobilization through integration of repetitive and static trunk strength and static strength of upper extremities with aerobic endurance. Fourth factor was predominantly defined by equilibrium; this factor is responsible for synergistic regulation of muscle function. Fifth factor yielded highest projections of the tests assessing rhythm coordination, followed by the tests of movement frequency, i.e. speed. Sixth factor was predominantly defined by the test of repetitive strength of lower extremities.

Factor analysis in the space of belly dance element scoring (Table 3) isolated only one factor defining belly dance performance in both age groups. All belly dance elements evaluated exerted high and significant projections upon the isolated factor, indicating strong association on performing all these elements, with the same subject of measurement in all belly dance elements.

Regression correlation analysis was carried out in both junior (1st and 2nd graders) and senior (3rd and 4th graders) female high school students to establish the relations of the latent motor variables obtained and criterion variables (belly dance performance) (Table 4).

In junior students, the factor of flexibility responsible for muscle tone regulation was found to be the best predictor of belly dance performance. Therefore, the development of flexibility was crucial for proper performance of belly dance elements in this group.

In senior students, the results of regression analysis indicated the isolated factors to be considerably better criterion predictors as compared with the results recorded in junior students (Table 4). Rhythm coordination was the best predictor of belly dance performance, followed by the factor of trunk strength and aerobic-muscular endurance, a factor integrating coordination and explosive strength of lower extremities, and factor of equilibrium.

The considerably higher criterion prediction in senior students relative to junior students (ρ, multiple correlation) resulted in the inclusion of a greater number of predictors in criterion determination. This led to a significantly greater integration of specific motor abilities and belly dance skills into the motor system of the 3rd and 4th grade students.

Discussion

Study results revealed the current belly dance program to reflect upon motor functions of female high school 1st–2nd and 3rd–4th graders. The impact manifested as differences in the structure of dimensions isolated in 3rd–4th graders relative to 1st–2nd graders. Appropriate motor structures consistent with belly dance performance were found to develop in female high school students. The motor factor structures obtained in 3rd and 4th graders showed higher homogeneity than those recorded in 1st and 2nd graders. In 1st and 2nd graders, the first factor was defined with a number of different basic motor abilities, whereas in 3rd and 4th graders it was defined by integration of coordination and lower extremity explosiveness. Unlike 1st and 2nd graders, the factor of explosive strength was not isolated in 3rd and 4th graders; however, a general factor responsible for the length of energy mobilization in terms of integration of aerobic-muscular endurance with repetitive and static strength (except for repetitive strength of lower extremities, which defined a separate factor) was isolated in the latter.

The results of regression analyses revealed the performance of belly dance elements in junior students to be predominantly limited by the development of muscle tone regulatory abilities. When a satisfactory level of flexibility development (i.e. the ability of muscle tone regulation) had been achieved, i.e. in senior high school students, belly dance performance was not determined

TABLE 4
RESULTS OF REGRESSION ANALYSIS BETWEEN THE SET OF PREDICTOR MOTOR VARIABLES AND CRITERION VARIABLE#

1st and 2nd graders (n=148)		3rd and 4th graders (n=123)	
Variable	β	Variable	β
Coordination, trunk strength, endurance	–0.09	Coordination, lower extremity explosiveness	–0.19[b]
Explosive strength	–0.05	Flexibility	–0.02
Flexibility	–0.23[a]	Trunk strength, endurance	–0.20[b]
Rhythm coordination	–0.11	Equilibrium#	0.18[b]
Equilibrium#	–0.06	Rhythm coordination	–0.23[a]
Back strength	–0.07	Lower extremity strength	–0.07
ρ	0.30[b]	ρ	0.41[a]

#variable with opposite metric orientation, [a]$p<0.01$, [b]$p<0.05$
β – regression coefficient, ρ – multiple correlation

by this basic motor ability anymore; instead, other factors were gradually involved in the determination of belly dance performance, primarily including the factor of rhythm coordination, then general motor factor responsible for the length of energy regulation of motion and general motor factor responsible for cortical regulation of motion and muscle force regulation, and eventually the factor of equilibrium.

Belly dance performance is predominantly associated with the abilities of energy regulation of movement in terms of appropriate activity of particular muscles and/or muscle groups, including lower leg, upper leg, hip, lower trunk, upper trunk, shoulders, upper arm, forearm and hand. Belly dance is only seemingly predominated by movements of the hips and trunk as the central body regions because this dance type activates the muscles of all body regions, by including muscles of one region while excluding muscles of other regions, or by including particular muscle(s) while excluding other muscles of a region, or by successively including all muscle groups of the body into an integral dance structure. This implies the abilities of inter-muscular and intra-muscular coordination and muscular tone fine regulation, in association with agility and leg explosive strength. Efficient belly dance performance requires proper integration of all these abilities.

Study results indicated the manifestation of coordination to be most pronounced only when other relevant motor abilities saturating coordination have reached a satisfactory level of development[13,17–22]. Obviously, the result in any kinesiologic activity including belly dance depends on the function of the general motor mechanism that integrates and regulates functions of all other mechanisms (in terms of information and energy components of movement)[2,3,13,17,19–24].

Because of their beauty and wealth of movements as well as the great variety of forms and rhythms, dances provide great opportunities for the development of esthetic awareness and sense for the beautiful[25].

Belly dance cannot be fully explained solely by the motor component of the anthropological system. Dance is more than pure motor activity. On performing belly dance, other components of the anthropological system, primarily emotional and conative personality features, are also being involved. Therefore, the role of belly dance in transforming not only morphological, motor and cognitive status of the attendees but also their psychosocial status should be assessed and evaluated. Along with relations at particular measurement points between the dimensions of psychosomatic status and belly dance performance, future studies will be focused on belly dance induced changes in these dimensions between the measurement points.

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UTJECAJ MOTORIČKIH SPOSOBNOSTI NA USPJEH U TRBUŠNOM PLESU UČENICA SREDNJE ŠKOLE

S A Ž E T A K

Cilj ovoga istraživanja bio je utvrditi međusobnu determiniranost motoričkih sposobnosti i uspjeha u trbušnom plesu kod učenica prvog do četvrtog razreda srednje škole u dobi od 15–18 godina. U tu svrhu je na uzorku od 148 učenica u dobi od 15–16 godina (1. i 2. razred) i uzorku od 123 učenice u dobi od 17–18 godina (3. i 4. razred) primijenjen skup od 19 motoričkih testova, te izvršeno ocjenjivanje devet elemenata trbušnog plesa. Faktorskom analizom motoričkog prostora izolirano je po šest faktora za oba uzorka učenica: kod učenica 1. i 2. razreda prvi integrira koordinaciju, snagu trupa, aerobnu i mišićnu izdržljivost i brzinu pokreta nogu, drugi definira eksplozivnu snagu, treći fleksibilnost, četvrti koordinaciju u ritmu, peti ravnotežu i šesti snagu mišića leđa; kod učenica 3. i 4. razreda prvi integrira koordinaciju i eksplozivnu snagu nogu, drugi definira fleksibilnost, treći integrira snagu trupa i mišićnu i aerobnu izdržljivost, četvrti definira ravnotežu, peti koordinaciju u ritmu i šesti snagu nogu. Faktorskom analizom ocjena elemenata trbušnog plesa izoliran je jedan faktor kao faktor opće specifične sposobnosti za uspjeh u trbušnom plesu. Regresijska analiza u latentnom prostoru je pokazala da je kod učenica 1. i 2. razreda najbolji prediktor uspjeha u trbušnom plesu faktor fleksibilnosti koji je odgovoran za regulaciju mišićnog tonusa, dok je kod učenica 3. i 4. razreda najbolji prediktor uspjeha u trbušnom plesu faktor koordinacije u ritmu, a zatim faktor snage trupa i aerobno mišićne izdržljivosti, faktor koji integrira koordinaciju i eksplozivnost nogu, te faktor ravnoteže.